Child resistant actuation means for piezoelectric gas lighters

This invention relates to child resistant actuation means for gas lighters with piezoelectric ignition.

Piezoelectric gas lighters consist essentially of a small pressurized fuel gas container or reservoir, a valve which is operable to allow fuel to escape, and a piezoelectric spark generating device for igniting the gas, and benefit from simplicity, reliability and longevity in use. Common types of piezoelectric gas lighters include small cigarette lighters for carrying in the pocket, and utility lighters or gas lighting rods which are typically used for such purposes as igniting burners on gas cookers and lighting barbecues and camp fires.

It is well known that children are liable to play with lighters (whether cigarette lighters or utility lighters), and serious accidents can occur as a result. Lighters must therefore be designed to minimize the chance of a child being able to light them. In other words, they should be child-resistant, though perfect child-proofing is of course impossible. Ideally, an adult should be able to use the lighter easily and a child should find it impossibly difficult to use. But in practice this obviously cannot be achieved, and a lighter is regarded as child-resistant if it provides a balance between these two conflicting requirements which is as good as is reasonably feasible and which fulfils minimum child resistance criteria.

Lighters, both of the cigarette lighter and the utility lighter pattern, are typically subjected to frequent, repeated and often forceful use. They may also be stored in dirty or dusty conditions, such as in a pocket or drawer. It is very important that the components of the lighter on which its child resistancy depends are able to withstand such use and storage without failing in the operative condition.

Furthermore, it is observed that when small children play with a lighter they tend to do so by imitation and more or less random experimentation, rather than by

following a sequence of logical steps as an adult might approach a problem solving exercise. It is therefore desirable that a child resistant lighter should present an intellectual barrier to operation by the small child which reduces as far as possible the probability of successful operation as a result of this type of play.

A minimum standard for child resistance has been specified in the USA by means of a functional test by the Consumer Product Safety Commission: 16 CFR Parts 1145 and 1210, Risks of Injury Associated with Lighters That Can Be Operated by Children; Safety Standard for Cigarette Lighters; Rules: Federal Register, Monday July 12 1993. The degree to which a lighter is child resistant may be objectively determined by applying the test described in these Rules and Regulations.

A utility lighter incorporating a child resistant safety mechanism is shown in our earlier published PCT patent application, WO 00/08387. In that utility lighter, a control button or trigger is movable generally transversely to the body of the lighter to operate the fuel valve and the piezoelectric device, and a safety button is located roughly opposite the control button. The safety button is coupled to one arm of a cranked lever which is pivoted at the point where the two arms meet; the distal end of the second arm normally engages with the control button to prevent its depression. Depressing the safety button causes that second arm to move out of engagement with the control button, which is thereby released for movement. Thus in order to release fuel and ignite it, both buttons must be operated together, which in practice it is found difficult for small children to achieve.

Similarly, US 6,318,992 and US 6,332,772 to Sung disclose utility lighters wherein a resilient leaf is arranged to block depression of the trigger, and a separate safety button on the top of the lighter must be operated in order to open the fuel valve and move the resilient leaf to the non-obstructing position. The safety button may be freely operated, liberating fuel, but the fuel will not be ignited until the trigger is depressed. Once the safety button is held in the

operative position, the trigger may be depressed to activate the piezoelectric device and ignite the fuel.

It is possible that, during the working life of a gas lighter, and especially a utility lighter which has larger control elements or buttons, large forces may be applied to its operating mechanisms through careless or excessively vigorous use. Furthermore, some users may deliberately apply excessive force to a lighter in an attempt to defeat its child resistancy so as to make it easier to use. Under these circumstances it is possible that the cranked lever or the resilient leaf of the above mentioned devices may be damaged, impairing the child resistancy of the lighter and leaving it vulnerable to unintended use.

In order to overcome this problem an alternative class of safety mechanism has been proposed, in which the operating button or trigger of the lighter is arranged to be selectively disabled from operating the lighter without its movement being blocked. The adult user must then enable the trigger in addition to depressing it in order to operate the lighter.

US 6,135,763 to Man discloses a utility lighter which exemplifies the latter "enablement" approach. To operate the lighter, the user must enable the trigger by sliding it upwards towards the top of the lighter, so bringing a rearward extension on the trigger into alignment with the fuel release lever. Depression of the trigger will then release fuel and so produce a flame.

Although this lighter will not produce a flame when the trigger is depressed in the disabled condition, it will produce a spark. This is disadvantageous since it may be possible to ignite very flammable materials by means of the spark alone. The production of a spark when the trigger is depressed may also encourage a small child to continue to play with the lighter.

US 6,287,109 to Hirota & Co. Ltd. discloses a cigarette lighter having a disabled condition in which a slider piece on the top of the lighter may be depressed by the user without either producing a spark or releasing fuel. In order to ignite the lighter, the user must first slide the slider piece forwards towards the burner. This aligns a downwardly extending abutment on the slider piece with a corresponding abutment on a latch element which in turn operates the spark generator and the fuel release lever. The slider piece may then be depressed to operate the fuel lever and the spark generator and so produce a flame.

In both of the above mentioned devices the lighter is operated by a single trigger or operating button with two degrees of freedom. This makes it more likely that the child will achieve ignition by playing with the trigger, perhaps by gripping it with both hands while experimenting with all of its possible movements. It has been found in practice to be most desirable to physically separate the safety button and trigger functions so that the user must operate two separate elements in order to achieve ignition. In a utility lighter these are preferably positioned roughly opposite each other on the lighter casing so that an adult may operate them conveniently with the thumb and finger of one hand. Since a child under five years has smaller hands than an adult user it will find it difficult or impossible to reach both buttons simultaneously, and this physical separation of the trigger and safety button has proved in practice to be a significant barrier to successful operation by a child.

US 6,722,877 to Wang et al discloses a utility lighter which prevents spark generation in the disabled condition while achieving the required physical separation of the trigger and the safety button, by providing the trigger with a sliding disabling mechanism. The disabling mechanism has a wedge shaped finger at its lower end, which projects downwards between the trigger and the spark generator, and a rearwardly extending actuator, and is depressible by a separate safety button located on the top of the lighter casing. In the disabled condition the actuator and the finger are misaligned with the fuel lever and the spark generator

respectively so that depression of the trigger in this condition is ineffective to operate the lighter. In order to produce a flame, the user must depress the safety button so as to align the actuator with the fuel release lever and at the same time force the wedge shaped finger between a rear surface of the trigger and the spark generator. When the trigger is depressed the actuator then engages the lever and the spark generator is fully compressed by the trigger and the finger so that a spark is produced to ignite the released fuel.

An alternative arrangement is disclosed in US 6,336,807 to Hsu, which shows a utility lighter having a pair of sprung rods slidably mounted in a pivotable frame. The frame is pivoted by means of a separate safety lever on the side of the lighter casing to move the rods into alignment respectively with the fuel lever and the spark generator, so that when the trigger is depressed it presses against both of the rods to actuate the fuel lever and the spark generator and so produce a flame. In the disabled condition, the rods are misaligned so that the trigger may be depressed without producing a spark.

It is the aim of the present invention to provide a piezoelectric gas lighter which is convenient in use and provides effective and reliable child resistancy. Preferably the lighter should prevent the production of a spark in the disabled condition.

According to a first aspect of the present invention there is provided a piezoelectric lighter, including a casing, a reservoir containing fuel, a valve operable by a user for releasing fuel from the reservoir, a piezoelectric device for generating a spark for igniting the fuel, and at least a first control element, wherein the first control element is normally biased to a rest position and is displaceable by the user in at least a first direction to impart an actuating motion to the piezoelectric device; and further including an intermediate member for transferring the actuating motion from the first control element to the piezoelectric device, together with enabling means operable by the user to move the intermediate member in a second direction from a normal, disabled position,

wherein on displacement of the first control element in the first direction, the actuating motion is not transferred to operate the piezoelectric device, to an enabled position wherein on displacement of the first control element in the first direction, the actuating motion is transferred to operate the piezoelectric device;

characterised in that the intermediate member extends from a proximal end to a distal end, the proximal end being located at a fixed point on the first control element so as to be movable together with the first control element in the first direction, the distal end being movable relative to the proximal end in the second direction, and in that the distal end has a first engagement surface and the piezoelectric device includes a second engagement surface, and in use the first engagement surface engages the second engagement surface.

According to a second aspect the invention provides a piezoelectric lighter, including a casing, a reservoir containing fuel, a valve operable by a user for releasing fuel from the reservoir, a piezoelectric device for generating a spark for igniting the fuel, and at least a first control element, wherein the first control element is normally biased to a rest position and is displaceable by the user in at least a first direction to impart an actuating motion to the piezoelectric device; and further including an intermediate member for transferring the actuating motion from the first control element to the piezoelectric device, together with enabling means operable by the user to move the intermediate member in a second direction from a normal, disabled position, wherein on displacement of the first control element in the first direction, the actuating motion is not transferred to operate the piezoelectric device, to an enabled position wherein on displacement of the first control element in the first direction, the actuating motion is transferred to operate the piezoelectric device;

characterised in that the intermediate member extends from a proximal end to a distal end, the proximal end being located at a fixed point on a part of the piezoelectric device so as to be movable together with the said part of the

piezoelectric device in the first direction, the distal end being movable relative to the proximal end in the second direction, and in that the distal end has a first engagement surface and the first control element includes a second engagement surface, and in use the first engagement surface engages the second engagement surface.

According to a third aspect the invention provides a piezoelectric lighter, including a casing, a reservoir containing fuel, a valve operable by a user for releasing fuel from the reservoir, a piezoelectric device for generating a spark for igniting the fuel, and at least a first control element, wherein the first control element is normally biased to a rest position and is displaceable by the user in at least a first direction to impart an actuating motion to the piezoelectric device; and further including an intermediate member for transferring the actuating motion from the first control element to the piezoelectric device, together with enabling means operable by the user to move the intermediate member in a second direction from a normal, disabled position, wherein on displacement of the first control element in the first direction, the actuating motion is not transferred to operate the piezoelectric device, to an enabled position wherein on displacement of the first control element in the first direction, the actuating motion is transferred to operate the piezoelectric device;

characterised in that the intermediate member is a separate element mounted independently of the first control element and of the piezoelectric device for translational movement in the second direction between the disabled position and the enabled position, the intermediate member having two first engagement surfaces and the first control element and the piezoelectric device having each respectively a second engagement surface, wherein in use, in the enabled position the first engagement surfaces engage each respectively of the second engagement surfaces, and in the disabled position the first engagement surfaces engage neither of the second engagement surfaces.

In a fourth aspect the invention provides a piezoelectric lighter, including a casing, a reservoir containing fuel, at least a first control element, and two operating components operable by a user, the operating components comprising a valve for releasing fuel from the reservoir and a piezoelectric spark generating device for igniting the fuel, wherein the first control element is normally biased to a rest position and is displaceable by the user in at least a first direction to impart an actuating motion to at least one said operating component; and further including engagement means for transferring the actuating motion from the first control element to the said at least one operating component, together with enabling means operable by the user to set the engagement means from a normal, disabled condition, wherein on displacement of the first control element in the first direction, the actuating motion is not transferred to operate the said at least one operating component, to an enabled condition wherein on displacement of the first control element in the first direction, the actuating motion is transferred to operate the said at least one operating component;

characterised in that the engagement means include a first frictional engagement surface and there is provided a second frictional engagement surface, wherein in the disabled condition the frictional engagement surfaces are arranged so as to move past each other when the first control element is displaced in the first direction, and the enabling means are operable to engage the frictional engagement surfaces together in a plurality of positions corresponding to the progressive displacement of the first control element in the first direction.

In a fifth aspect the invention provides a piezoelectric lighter, including a casing, a reservoir containing fuel, at least a first control element, and two operating components operable by a user, the operating components comprising a valve for releasing fuel from the reservoir and a piezoelectric spark generating device for igniting the fuel, wherein the first control element is normally biased to a rest position and is displaceable by the user in at least a first direction to impart an actuating motion to at least one said operating component; and further including

an intermediate member for transferring the actuating motion from the first control element to the said at least one operating component, together with enabling means operable by the user to set the intermediate member from a normal, disabled condition, wherein on displacement of the first control element in the first direction, the actuating motion is not transferred to operate the said at least one operating component, to an enabled condition wherein on displacement of the first control element in the first direction, the actuating motion is transferred to operate the said at least one operating component;

characterised in that the intermediate member includes first and second ends operatively connected respectively with the first control element and the said at least one operating component, and an intermediate section disposed between the first and second ends, and the intermediate section is flexible so as to define a variable distance of separation between the first and second ends, wherein in the disabled condition the distance of separation between the first and second ends is reducible by displacement of the intermediate section in a second direction, and in the enabled condition the displacement of the intermediate section is restrained in the said second direction during movement of the intermediate member in the direction of the actuating motion.

In a sixth aspect the invention provides a piezoelectric lighter, including a casing, a reservoir containing fuel, at least a first control element, and two operating components operable by a user, the operating components comprising a valve for releasing fuel from the reservoir and a piezoelectric spark generating device for igniting the fuel, wherein the first control element is normally biased to a rest position and is displaceable by the user in at least a first direction to impart an actuating motion to at least one said operating component; and further including enabling means operable by the user to set the lighter from a normal, disabled condition, wherein on displacement of the first control element in the first direction, the actuating motion is not transferred to operate the said at least one operating component, to an enabled condition wherein on displacement of the first

control element in the first direction, the actuating motion is transferred to operate the said at least one operating component;

characterised in that the lighter is set to the enabled condition by continuous operation of the enabling means during displacement of the first control element in the first direction, and in that there are provided disengagement means, wherein when the operation of the enabling means is interrupted during displacement of the first control element in the first direction the disengagement means return the lighter to the disabled condition.

The present invention in each of its aspects provides a child resistant mechanism which combines a high degree of both physical and intellectual difficulty for children with convenience for the adult user, while being resistant to damage and difficult to defeat. The application of excessive force to the first control element or trigger when the intermediate member is in the disabled position merely results in the abutment of the trigger against the lighter body or other components without actuation of the lighter, leaving the child resistancy of the lighter unimpaired.

In preferred embodiments the invention prevents the production of a spark in the disabled condition. Furthermore, the user is preferably required to adhere to a strict sequence of operation and to operate two control elements simultaneously and continuously in order to achieve ignition, requiring a combination of force and coordination which makes it still more difficult for a small child to operate the lighter.

Further advantages and features of the invention will become apparent from the following description and the accompanying drawings, in which various embodiments are described solely by way of illustration and without any limitation to the scope of the invention. Referring to the drawings:

Fig. 1A is a simplified longitudinal section of a first lighter according to a first embodiment of the invention, with some components omitted for clarity, showing the control button in the rest position and the intermediate member in the disabled position;

Fig. 1B shows the first lighter with the control button in the fully depressed position and the intermediate member in the disabled position;

Fig. 1C shows the first lighter with the control button in the rest position and the intermediate member in the enabled position;

Fig. 1D shows the first lighter with the control button in the fully depressed position and the intermediate member in the enabled position;

Fig. 1E shows in simplified form an alternative implementation of the first lighter, with one half of the casing removed and the trigger shown in longitudinal section;

Figs. 2A, 2B, 2C and 2D are views corresponding to Figs. 1A – 1D of a second lighter according to a second embodiment;

Fig. 3A is a simplified longitudinal section of a third lighter according to a third embodiment of the invention, again with some components omitted for clarity, showing the control button in the rest position and the intermediate member in the disabled position;

Fig. 3B is an enlarged view of the area 3B of Fig. 3A;

Fig. 3C shows the third lighter with the control button in the fully depressed position and the intermediate member in the disabled position;

Fig. 3D shows the third lighter with the control button in the rest position and the intermediate member in the enabled position;

Fig. 3E is an enlarged view of the area 3E of Fig. 3F;

Fig. 3F shows the third lighter with the control button in the fully depressed position and the intermediate member in the enabled position;

Fig. 4A is a similar longitudinal section of a fourth lighter according to a fourth embodiment of the invention, showing the control button in the rest position and the intermediate member in the disabled position;

Fig. 4B is an enlarged view of the area 4B of Fig. 4A;

Fig. 4C shows the fourth lighter with the control button in the fully depressed position and the intermediate member in the disabled position;

Fig. 4D shows the fourth lighter with the control button in the rest position and the intermediate member in the enabled position;

Fig. 4E is an enlarged view of the area 4E of Fig. 4F;

Fig. 4F shows the fourth lighter with the control button in the fully depressed position and the intermediate member in the enabled position;

Fig. 5A is a similar longitudinal section of a fifth lighter according to a fifth embodiment of the invention, showing the control button in the rest position and the intermediate member in the disabled condition;

Fig. 5B is an enlarged view of the area 5B of Fig. 5A;

Fig. 5C shows the fifth lighter with the control button in a partially depressed position and the intermediate member in the disabled condition;

Fig. 5D is an enlarged view of the area 5D of Fig. 5E; and

Fig. 5E shows the fifth lighter with the control button in the fully depressed position and the intermediate member in the enabled position.

Corresponding reference numerals are used for corresponding parts throughout.

Referring to Figs. 1A – 1D, a piezoelectric utility lighter includes a lighter body shell or casing 1, which may be moulded from plastics material and supports a barrel 2, conveniently formed from stainless steel. The body contains a reservoir of pressurised fuel such as butane or the like, which may be released from the reservoir by means of a valve, conveniently controlled by a lever which is operable by the user. The liberated gas is conducted along a tube or the like to a nozzle situated in the tip of the barrel 2, where it is ignited by a spark formed by an electrical discharge between the nozzle and the barrel, which form electrodes separated by a spark gap. Of course, separate electrodes might alternatively be provided. The discharge is generated by compression of the piezoelectric actuator 20, which is connected to the electrodes by conductors.

A first control element or trigger 30 is conveniently moulded from plastics material and is normally biased to the rest position shown in Figs. 1A and 1C by a spring 38. A resilient leaf or the like might alternatively be used as biasing means. The trigger slides reciprocally into the lighter shell when pressed inwards by the user's finger in a first direction, indicated by the arrow A; a stop surface 32 may be provided on the trigger to contact a corresponding surface 33 on the lighter body, preventing further inward movement when maximally depressed.

A resiliently biased intermediate member 40 is formed as a resilient tab or leaf having a proximal end 40' which is located at a fixed point on the control element, and extending generally in the first direction to its opposite, distal end 40". In the example shown, the intermediate member is moulded from plastics material as an integral part of the trigger. Alternatively it may be formed from spring steel, plastics or any other suitable material and mounted at a fixed point on the trigger.

The intermediate member is provided at its distal end 40" with a first engagement surface 42, and normally occupies a disengaged or rest position as shown in Figs. 1A and 1B, where the engagement surface 42 is out of alignment with a second engagement surface 22 formed on the piezoelectric device 20. When the trigger 30 is displaced by the user in the first direction A from the rest position (Fig. 1A) to the operated position (Fig. 1B) the intermediate member slides freely past the piezoelectric device 20 so that it does not transfer the actuating motion A to the piezoelectric device and no spark is generated. The application of further force to the trigger merely results in the abutment of the trigger against the stop surface 33, thus avoiding damage to the intermediate member.

By forming it as part of the trigger, the intermediate member benefits from simplicity and economy of construction and provides an extremely compact mechanism which needs very little room to operate, enabling the overall size of the lighter body to be reduced and saving in materials costs.

A second control element or safety button 50 operable separately from the trigger is provided on an upper surface of the lighter body remote from the trigger. The safety button thus lies generally above and on an opposite side of the lighter from the trigger, where it cannot be operated together with the trigger by one finger, but may be conveniently operated by the thumb of an adult user whilst the trigger is operated simultaneously by a finger of the same hand. The safety button 50 is recessed into a slight concavity 3 in the lighter body, which makes it more difficult for a child to operate it by pressing the lighter against a surface.

The generally backward, longitudinal motion of the trigger and the generally downward, transverse motion of the safety button create a natural combination of movements for the user. At the same time, the spaced-apart configuration of the buttons makes it very difficult for a child with small hands to operate both buttons together. While it might be possible for a child to achieve ignition by experimenting with all the possible movements of a single button, perhaps by gripping the lighter with both hands on the same button, it is far more difficult for it to coordinate the operation of two separate buttons, especially where each must be operated with a separate hand.

Alternative configurations of trigger and safety button are of course possible.

The safety button 50 has a stem 52 which bears axially against the resilient leaf 40, so that the resilient leaf upwardly biases the safety button towards its rest position. The sliding engagement point between the stem and the resilient leaf is substantially in line with the actuation force which is transmitted in use from the trigger to the piezoelectric device; this helps to mimimise torque on the trigger and consequent distortion.

The safety button 50 may be formed without locking means. Preferably however it includes locking means, and conveniently it is located in a slot 4 in the lighter body so that it is displaceable by the user in a first, unlocking direction B generally parallel with the first direction A. The stem 52 is resiliently deformable transversely to its longitudinal axis, and normally biases the safety button to a first, locked position as shown in Figs. 1A and 1B, in which a locking surface 53 on the lower face of the head of the button engages an upper surface 5 of the body. This locking surface forms locking means which prevents displacement of the safety button in a second, enabling direction C.

Separate biasing means such as a spring (not shown) may also be provided to bias the safety button to its rest position. A collar 54 may be provided to retain the safety button to the lighter body, and the separate biasing means (not shown) may be arranged between the collar 54 and a guide 6 forming part of the lighter body which slidingly retains the stem 52.

The separate biasing means may further be arranged to increase the force required to operate the safety button and engage the intermediate member – for example by providing a relatively strong spring – and hence further enhance the child resistancy of the lighter, since children will find it particularly difficult to coordinate operation of the trigger and the safety button while at the same time providing the requisite force.

Rather than being depressible, the safety button might alternatively be arranged to slide or rotate on the surface of the lighter body. The stem might then be formed for example as a separate component cooperating with a ramped surface on the reverse of the safety button, or alternatively for example as a cranked lever, or a flexible or pivoted member extending from the safety button and slidingly engaging an oblique fixed surface on the lighter body, so as to exert a force generally transverse to the direction of movement of the sliding or rotating safety button. Equivalent arrangements will be readily apparent to those skilled in the art.

Returning to Figs. 1A – 1D, in order to operate the lighter, the user must first displace the safety button 50 in the unlocking direction B so as to move it to the unlocked position shown in Figs. 1C and 1D, where surfaces 5 and 53 are no longer in alignment. The stem 52 bends sideways to accommodate the movement. The safety button 50 may then be depressed in the second, enabling direction C so as to flexibly displace the distal end 40" of the intermediate member 40 generally transversely to the first direction A and relative to the proximal end 40' into the enabled position, as shown in Fig. 1C. In the enabled position, the engagement

surface 42 formed on the intermediate member abuts the second engagement surface 22 on the piezoelectric device 20.

While pressing the safety button downwards C to retain the intermediate member in this position, the user may then operate the trigger 30 so that it moves together with the proximal end 40' of the intermediate member in the first direction A. The intermediate member then bears against the piezoelectric device and transfers the actuating motion A from the trigger so as to compress the piezoelectric device as the trigger is displaced, creating a spark which ignites the released fuel. The lower end 59 of the stem 52 of the safety button bears slidingly against the intermediate member 40 so that the intermediate member slides past it as the trigger is depressed. Alternative arrangements may be employed for engaging the safety button with the intermediate member.

Referring to Fig. 1E, in an alternative implementation the first lighter is provided with a separate intermediate member 40, formed generally as described above as a resilient leaf and mounted at its proximal end 40' at a fixed position on the trigger 30. The distal end 40" of the leaf is provided with a first engagement surface 42' which in use engages a second engagement surface 22' formed on the piezoelectric device.

In all of the illustrated embodiments, the intermediate member is free to return to the disabled position if the safety button is released. It will be noted however that in this implementation, as a further safety enhancement the first engagement surface 42' is sloped slightly upwardly towards the top of the lighter and forwardly in the first direction of movement of the trigger A, while the second engagement surface is sloped slightly upwardly and backwardly in the first direction. The first and second engagement surfaces 22', 42' thus form disengagement means whereby the inclined surfaces 22', 42' tend to slide past each other under the trigger pressure and hence convert a part of the force which is applied by the user to the trigger 30 into a disengaging force. This disengaging

force acts to urge the intermediate member 40 out of engagement with the piezoelectric device 20 and into the disabled position during depression of the trigger. The disengaging force is counteracted in use by continued downward pressure by the user on the safety button 50'.

The safety button 50' is mounted slidingly in a carrier 501, which in turn is pivotably mounted about an axle 502 in the lighter body 1 and biased by the resilient leaf 40, which bears upwardly on a sliding engagement surface 503 of the carrier, to the upward or disabled position as illustrated.

In order to operate the lighter, the user must first push the safety button 50' forwards relative to the carrier and against the restoring force of a spring 504 in an unlocking direction B, generally parallel with and opposite to the first direction A, so that an abutting surface 53' on the bottom of the safety button 50' moves out of alignment with an abutment 5' formed on the lighter body 1.

Once the safety button has cleared the abutment 5', it may be depressed downwards in an enabling direction C together with the carrier 501 so that the engagement surface 503 of the carrier pushes the intermediate member 40 downwards into the enabled position, wherein the engagement surfaces 22', 42' are almost in abutment.

The user may then depress the trigger 30 in the first direction A, while maintaining constant downward pressure on the safety button 50' in the enabling direction C to counteract the disengagement force, so as to compress the piezoelectric device 20 and ignite the lighter. However, if at any point during the movement of the trigger 30 to its fully depressed position, the user should relax his downward pressure on the safety button, the disengagement force will cause the intermediate member 40 to move out of the enabled position towards the disabled position. As soon as this initial upward movement occurs, the piezoelectric device will resile towards its normal position while continued

pressure on the trigger will cause the intermediate member to slide up the ramped disengagement surface 22' and past the piezoelectric device 20. The lighter will then be inoperable until the user has relaxed pressure on the trigger so that it can return to the rest position. At the same time, when pressure is relaxed on the safety button the resilient leaf 40 will urge the carrier 501 upwards until the abutting surface 53' is able to slip past the fixed abutment 5' and the safety button is returned to the initial, locked position by the spring 504.

In the disabled condition of the lighter as shown, the engagement surfaces 22', 42' are substantially in alignment along a line generally transverse to the first direction of movement A. As a result, when the intermediate member is fully displaced to the enabled position, only negligible movement of the trigger in the first direction is required to bring the two engagement surfaces into abutment with one another. This ensures that any substantial movement of the trigger in the first direction before the safety button is fully depressed in the enabling direction C will cause the engagement surface 42' of the intermediate element to travel past the engagement surface 22' of the piezoelectric device. The lower surface 42" of the intermediate element together with the inclined engagement surface 42', and the upper surface 22" of the piezoelectric device together with the inclined engagement surface 22', then form blocking surfaces which travel past each other in the disabled condition. If the user then attempts to depress the operating button, the blocking surfaces engage one another to prevent the intermediate element from being displaced to the enabled position until the trigger is returned to the rest position.

The blocking surfaces 22", 42" thus ensure that the user must follow a strict sequence of operation, by depressing the safety button before beginning to depress the trigger, in order to operate the lighter. Initial depression of the trigger by more than a negligible predetermined amount prior to depression of the safety button will render the lighter inoperable.

The distance between the engagement surfaces 22', 42' in the disabled condition in the first direction A determines the degree of initial movement of the trigger which is possible before the blocking surfaces engage one another and the lighter becomes inoperable. Thus, were the engagement surfaces to be positioned so as to leave a larger gap between them when the safety button was depressed, the user would be able to partially depress the trigger before depressing the safety button, and still achieve ignition. Where however the engagement surfaces are formed as shown so that they are virtually in contact when the safety button is depressed, any significant movement of the trigger in the first direction prior to depression of the safety button will render the lighter inoperable. This further reduces the degree of freedom of the user to depart from the correct sequence of operation.

By providing inclined disengagement surfaces 22', 42' which together form disengagement means to urge the intermediate member to the disabled condition, the user is required to maintain constant pressure on the safety button from first depression of the trigger until ignition of the lighter. Although the disengagement means are conveniently provided by sloping the engagement surfaces as shown, separate disengagement means could alternatively be provided for disengaging the engagement surfaces in the event of a relaxation of pressure on the safety button during depression of the trigger.

In practice, the disengagement means could merely comprise very slightly inclined engagement surfaces which provide just enough disengagement force to overcome the frictional engagement between the intermediate member and the piezoelectric device under pressure from the trigger, so as to ensure that the intermediate member disengages reliably from the piezoelectric device if the safety button is released during depression of the trigger. Alternatively the disengagement means could comprise more acutely angled engagement surfaces, so that the user must apply a larger force to the safety button which is proportional to the force applied to the trigger.

Each of the abovementioned features – blocking surfaces, substantially aligned engagement surfaces, and disengagement means – makes the lighter more difficult for children to operate. By providing all three features in combination the present lighter requires the user to adhere strictly to the correct sequence and method of operation until a flame is produced, so that any deviation therefrom will instantly inactivate the lighter until the trigger is returned to the rest position. Since children will typically play with a lighter by imitation and random experimentation, this imposes a significant additional intellectual barrier for the child in attempting to operate the lighter because the child is most unlikely to carry out the correct operations in the correct order.

When the lighter is operated, fuel is released from the reservoir to the nozzle by means of a valve operated by a lever 7. In the example illustrated, the lever is operated by a rearward extension (not shown) of the trigger 30, so that fuel is released when the trigger is depressed. Alternatively, the lever may be operated by an extension of the intermediate element 40 which is engaged with the lever only in the enabled position, so that fuel release occurs together with actuation of the piezoelectric device. Alternatively the lever may be operated by an extension of the carrier 501 so that fuel is released when the safety button is depressed.

In a further alternative embodiment, the intermediate member may be formed as a substantially rigid element which extends generally in the first direction from a proximal end which is pivotably mounted, such as by means of a hinge or a socket, at a fixed point on the trigger, to its opposite, distal end. The distal end may then be moved, similarly to the resilient leaf illustrated, generally tranversely to the first direction and relative to the proximal end by pivoting it towards the engaged position about its fixed mounting point against a suitable restoring force, provided for example by a spring.

During the lifetime of a lighter, it is possible that large forces will be applied by the adult user to the trigger or operating button, especially in utility lighters where

the trigger is relatively large. The lighter body is provided with guiding surfaces to constrain the movement of the trigger and prevent it from twisting during use. However, the abuse of any lighter, resulting in the application of an exceptionally large force to the trigger or operating button, may be expected to result in some small degree of twisting or deformation, especially where torque is generated by the non-linear transfer of force from the trigger to the internal lighter components.

Where the intermediate member is located on the trigger and extends substantially away from the trigger, a small degree of twisting or deformation of the trigger will necessarily be amplified at the distal end of the intermediate element, and depending on the arrangement of the internal lighter components this may result in unintended enablement of some lighters.

This risk is minimised in the embodiments described by ensuring that the trigger may be fully depressed in all conditions of the lighter, irrespective of whether the safety button is in the fully enabled position, the disabled position, or midway between the enabled and disabled positions. The normal movement of the trigger is thus never blocked so that the risk of repeated stressing and damage to internal safety related components of the lighter is minimised.

Where the intermediate element is provided as an extension of the trigger, the risk is reduced still further as described above by providing for the distal end of the intermediate element to be resiliently moveable relative to the proximal end in a direction generally transverse to the first direction. This ensures that any unintended twisting of the trigger is compensated by the resilience of the intermediate element to maintain the first and second engagement surfaces in their proper relationship.

In order to reduce yet further the possibility of inadvertent actuation, the proximal end of the intermediate member may be located at a fixed point on the piezoelectric device, and the second engagement surface on part of the trigger, as

described in the following embodiment. This ensures that the intermediate member cannot be displaced from its proper position as a result of large forces applied to the trigger, while minimising any unintended displacement of the second engagement surface.

Referring to Figs. 2A – 2D, in a second embodiment a second lighter is formed similarly to the first lighter, but includes a flexible intermediate member 60 which extends generally in the first direction between a proximal end 60', mounted at a fixed point on the mobile part of the piezoelectric device 20, and a distal end 60" which is moveable relative to the proximal end and generally transversely to the first direction. In the example illustrated the intermediate member is a resilient leaf which has an engagement surface 62 at its distal end 60", and is moulded integrally from plastics material with the piezoelectric device 20. Alternatively it may be formed as a separate resilient component, for example as a leaf made from steel, plastics or other suitable material and mounted at its proximal end at a fixed point on the piezoelectric device. A corresponding engagement surface 36 is formed on the trigger 30. The resilient leaf 60 normally occupies a disabled or rest position as shown in Figs. 2A and 2B, where the surfaces 62 and 36 are out of abutment. Alternatively the intermediate member may be pivotably mounted by means of a hinge, a ball and socket, or other suitable arrangement at a fixed point on the piezoelectric unit, and separate resilient biasing means provided to bias its distal end to the disabled position. The second lighter benefits from compactness and economy of construction similar to that of the first lighter.

In the disabled position, the trigger 30 may be freely displaced by the user in the first direction A from the rest position (Fig. 2A) to the fully depressed position (Fig. 2B) without operating the lighter, since in this position the intermediate member 60 slides freely past the trigger 30 and no spark is generated. The lower surface of the intermediate member 60 and the upper surface 30' of the trigger 30 thus form cooperating blocking surfaces which prevent movement of the

intermediate element to the enabled position if the trigger is depressed without first depressing the safety button 50.

The safety button 50 is provided with a stem 52 which bears on the resilient leaf 60 as described above with reference to the first lighter. In order to operate the lighter the user must first unlock B and depress C the safety button 50 so that the intermediate member is urged into the engaged position as shown in Fig. 2C. The engagement surfaces 62 and 36 are then brought into abutment, and the trigger 30 may be depressed A to displace the intermediate member 60 in the first direction. The intermediate member transfers the actuating motion A from the trigger to the piezoelectric device as it moves together with the mobile part of the piezoelectric device in the first direction, compressing the internal plexor spring and generating a spark to ignite the released fuel.

Similarly to the first lighter, one or both of the cooperating engagement surfaces 62, 36 may be formed with a slope so as to form disengagement surfaces which urge the intermediate member out of engagement if the safety button is fully or partially released during depression of the trigger.

By positioning the abutting engagement surfaces 62 and 36 so that they are substantially aligned in the rest position of the trigger as shown in Figs. 2A and 2C, which is to say that they are virtually touching when the safety button is depressed and the trigger is in the rest position, the further advantage is realised that initial movement of the trigger prior to engagement of the blocking surfaces in the disabled condition is minimised. This imposes an additional barrier to successful operation of the lighter by a child, who is less likely to adhere strictly to the correct sequence of operation. Thus if the child depresses the trigger and then successfully unlocks the safety button, any downward pressure it exerts on the safety button in the enabling direction C will merely engage the blocking surfaces against each other. The lighter cannot then be ignited until the trigger is first returned to the rest position.

For the sake of clarity not all operating components are shown in the illustrated embodiments. In all of the illustrated embodiments the fuel valve may be operated by the user together with the piezoelectric device by the first control element or trigger, for example by arranging a lever to cooperate with an abutment mounted on the intermediate element and so open the valve when the intermediate element is displaced in the first direction. This provides that neither fuel release nor spark generation is achieved until the correct sequence of enabling and actuating operations has been performed. Alternatively the fuel valve may be operated directly by the trigger, by arranging for a suitable fuel release lever to cooperate with an abutment formed on the trigger. Alternatively the valve may be operated directly by the enabling means, for example by means of a lever cooperating with an abutment formed on the safety button.

In each of the abovedescribed embodiments the intermediate member extends from a fixed point on the trigger or the piezoelectric device. Where it is formed as a separate or integral resilient leaf, it is preferably biased to the disabled position by its inherent resilience. Where it is formed alternatively as a substantially rigid element and mounted on the trigger or piezoelectric device by means of a hinge or the like, it is conveniently biased to the disabled position by separate spring means.

The simplicity and minimal number of components provided by each of these embodiments ensures that the intermediate element returns very reliably to the disabled position, and it is particularly to be noted that the movement of the intermediate element between its enabled and disabled positions is implemented without the translational displacement of any sliding surfaces. This ensures that, should dirt or dust enter the lighter casing (such as through the small gaps around the trigger and the safety button), there is no possibility of its becoming entrapped between such sliding surfaces so as to cause the intermediate element to jam in its enabled position and hence compromise the child resistancy of the lighter.

Furthermore, by providing for the distal end of the intermediate element to move relative to the fixed mounting point of the proximal end, maximum torque is provided at the fixed mounting point at the proximal end when returning the intermediate element to the disabled position. Where the intermediate element is implemented as a rigid element and hinged to the trigger or the piezoelectric device, this ensures that any slight wear or stickiness of the hinge which may occur over the lifetime of the lighter cannot be sufficient to prevent the intermediate element from returning reliably to the disabled position.

Referring to Figs. 3A – 3F, a third lighter includes a trigger 30 and piezoelectric device 20 as described above, but has an intermediate member 70 which is formed as a separate element mounted for translational movement on the lighter casing independently of the trigger and of the piezoelectric device and engageable with both the trigger and the piezoelectric device in the enabled position. The intermediate member is movable by translation in the enabling direction C substantially transverse to the first direction A between a disabled position (Figs. 3A, 3B, 3C) and an enabled position (Figs. 3D, 3E, 3F), and in the illustrated example is resiliently biased towards the disabled position by a spring 73 mounted within the trigger and slidingly engaging the lower surface of the plate. Alternative biasing means may be employed.

By mounting the intermediate element on the lighter body and independently of the trigger, it is isolated similarly to the second embodiment from any possible unintended displacement as a result of large forces which may be applied to the trigger.

The flat configuration of the plate 70 also allows a compact and cost effective assembly with a minimal range of movement, although other forms are of course possible. Since the intermediate element, and hence the safety button 50 are only required to move through a small range of translational movement between the

enabled and disabled positions, the safety button may be formed as a small component with a low profile and hence is less vulnerable to unintended operation by infants than would be a larger component with a larger range of motion. The small range of movement of the safety button thus achieved makes it particularly difficult for the infant to appreciate the necessity of maintaining it in the fully enabled (depressed) position and to apply enough pressure to it to prevent it from rising slightly into the disabled position, especially where the required pressure is proportional to the pressure applied to the trigger as further described below.

In operation the enabling means or safety button 50 is first displaced in the unlocking B and enabling C directions so as to move the plate 70 downwards into the enabled position, where engaging surfaces 71, 72 formed on the plate engage corresponding engaging surfaces 36, 22 on the trigger and piezoelectric device. Guides (not shown) may be formed on the plate to cooperate with guiding structures formed on the lighter body 1 so as to maintain the plate in the correct orientation within the body.

The translational movement of the intermediate member transverse to the first direction makes it possible for the engagement surface 71 to be substantially aligned (but for a small clearance x) in the first direction A with the corresponding engagement surface 36 on the trigger, as best seen in Fig. 3B, when the intermediate member is in the disabled position. This ensures that the engagement surfaces 71 and 36 are substantially in abutment when the intermediate element is displaced in the enabling direction C to the enabled condition while the trigger is in the rest position, as shown in Fig. 3D.

The lower surface 71" of the intermediate element and a corresponding upper surface 36" of the trigger form cooperating blocking surfaces, so that unless the safety button 50 is first fully depressed, once the trigger 30 has been displaced through at least an initial predetermined distance the blocking surfaces come into abutment and slide past each other as shown in Fig. 3C. This prevents the

intermediate element from being displaced to the enabled position until the trigger is returned to the rest position. By forming the corresponding engagement surfaces 71, 36 so that they are substantially aligned prior to operation of the trigger, the initial distance is reduced to a value x which corresponds to a negligible movement of the first control element as can be seen from Fig. 3B. This makes it still more difficult for an infant to operate the lighter while playing with the trigger.

The engagement surfaces may be formed as plain abutting surfaces transverse to the direction of the actuating motion A. In the embodiment shown however, the engaging surface 36 is angled relative to the first direction A and upwardly and forwardly towards the nozzle or barrel 2 of the lighter so as to form a disengagement surface, which generates a disengagement force to urge the engagement surface 71 out of engagement as the trigger is moved in the first direction A. The blocking surface 36" is progressively curved in the same direction so as to urge the intermediate member still further towards the disabled position. The remaining engagement surfaces may similarly be implemented as angled disengagement surfaces.

The disengagement surfaces require the user to apply additional and continuous force on the enabling means or safety button 50 in the enabling direction C in order to maintain the intermediate member in the enabled position during operation of the lighter. If insufficient force is applied to the enabling means during displacement of the trigger, the intermediate element will slip past the angled disengagement and blocking surfaces without transferring the actuating motion to the piezoelectric device. In the disabled position (Figs. 3A – 3C) the intermediate member engages neither the trigger nor the piezoelectric device.

In a further alternative embodiment, a piezoelectric lighter is provided with engagement means for selectively frictionally engaging the trigger with the valve and/or with the piezoelectric device so as to transfer the actuating force from the

trigger to the valve or (more preferably) to the piezoelectric device as the trigger is depressed. In its simplest form, the engagement means comprise a first frictional engagement surface, which may be formed directly on the trigger or on the operating component, which is engageable with a second frictional engagement surface formed on the other component. Either the trigger or (more preferably) the operating component, or both, may then be mounted (such as by pivoting on an axle or sliding in a guide formed on the lighter body) for movement in a second direction, conveniently transverse or oblique to the first operating direction of the trigger, and resiliently biased to a disabled rest position in which the two frictional engagement surfaces slide past each other when the trigger is depressed. In practice, a very small amount of movement in the second direction may suffice, and it may be sufficient for example to provide a resilient mounting for one or both components.

The lighter may then be enabled by moving the trigger or, more preferably, the operating component in the second direction to an enabled position so as to frictionally engage the two frictional engagement surfaces together prior to displacement of the trigger in the first direction. The frictional engagement surfaces must then be maintained in engagement during depression of the trigger in order to produce a flame. When a child plays with the lighter however, it may operate the enabling means to move the trigger or operating component in the second direction at any point during depression of the trigger. In this case the two surfaces may be frictionally engaged together in any of a plurality of positions, corresponding to the progressive depression of the trigger, and although the lighter will then appear to the child to be operating correctly, ignition (and/or fuel release) will not then be achieved. This presents a further intellectual barrier to operation by small children.

More conveniently, the engagement means comprise an intermediate member on which the first frictional engagement surface is formed. Referring to Figs. 4A – 4F, a fourth lighter is accordingly formed similarly to the second lighter with a

trigger 30 for imparting an actuating motion to a piezoelectric device 20 via an intermediate member 60 which forms part of the piezoelectric device. In this embodiment the intermediate member 60 has a frictional engagement surface 63 which in the enabled condition (Figs. 4D – 4F) is urged into engagement with a corresponding frictional engagement surface 37 formed on the trigger, by unlocking B and then depressing C the safety button as described with reference to the second lighter. The actuating motion A of the trigger 30 may then be transferred through the frictional engagement surfaces to the piezoelectric device 20. The lower end 59 of the stem 52 of the enabling means bears axially and slidingly on the smooth upper surface of the intermediate member 60 so that the intermediate member can slide past it in operation.

Similarly to the foregoing embodiments, the trigger has a stop surface 32 which abuts a corresponding stop surface 33 on the lighter body to define the maximum limit of travel of the trigger in the first direction A. The separation between these two surfaces defines a maximum distance of displacement M of the trigger in the first direction, which in turn defines the maximum length of the actuating stroke which may be imparted to the piezoelectric device before the trigger abuts the body.

Desirably, the piezoelectric device 20 (and/or, where the intermediate member is arranged alternatively or additionally to act on the valve mechanism, the lever or other valve control means) is arranged so as to be inoperable by means of an actuating stroke substantially shorter than the distance M. In practice the actuating stroke required will be an inherent characteristic of the operating component in question, whether the piezoelectric device or the valve, so the positioning of the stop surfaces may conveniently be adjusted to suit.

The two frictional engagement surfaces 37, 63 are formed generally in parallel with the direction A of the actuating motion, so that in the disabled position (Figs. 4A – 4C) they slip past each other when the trigger is depressed, as shown in Fig.

4C. The surface 37 on the trigger is extended so that the surface 63 on the intermediate member may engage it at any point along its length. This enables the trigger to be progressively depressed to any position in the first direction A before depression of the safety button in the enabling direction C engages the frictional engagement surfaces together so as to transfer the actuating force from the trigger to the intermediate member. Thus the frictional engagement surfaces may be engaged together in a plurality of positions corresponding to the position of the trigger. Where the intermediate element is formed with small teeth as shown, the number of possible positions of engagement will correspond to the number of teeth.

However, where the trigger is depressed before the safety button, only part of the maximum trigger stroke M is then transferred to the operating component (piezoelectric device and / or valve), so that the lighter does not produce a flame. Similarly, where the force applied to the safety button 50 in the enabling direction C during operation of the trigger is reduced below the minimum necessary to maintain frictional engagement between the two engagement surfaces, the surfaces will move or slip partially past each other, shortening the applied stroke and preventing successful operation of the lighter. This makes it even harder for an infant to understand how the lighter works.

Desirably, where the frictional engagement surfaces are formed with small teeth, each tooth is ramped as shown so that if pressure is relaxed on the safety button, the abutting surfaces of the teeth form disengagement surfaces which urge the intermediate element to the disabled position under pressure from the trigger.

The distance of separation between the two components during operation of the lighter is thus not only dependent on the correct sequence of operation but is also proportional to the force applied to the safety button 50 by the user. As described above, the minimum enabling force for maintaining engagement between the two engagement surfaces will depend inter alia on the frictional characteristics and

areal extent of the engagement surfaces, and the stiffness of the piezoelectric device; it may also be enhanced by additional springs acting between the lighter body and either or both of the trigger and the safety button. Although the frictional engagement surfaces are shown by way of illustration with visible teeth, in practice they might be formed for example from plastics or rubber material having a smooth or roughened surface with the required frictional characteristics.

It will be appreciated that the intermediate member of the fourth lighter need not form part of the piezoelectric device; for example, it might alternatively be arranged on the trigger or as a separate element cooperating with both the trigger and the piezoelectric device and having separate frictional engagement surfaces for engaging one or both components.

Piezoelectric spark generating devices typically comprise a stiff spring loaded hammer component or plexor which is first pre-loaded by compression and then released automatically to impact on the spark generating crystal; the device is not fired unless the full working stroke is accomplished. Devices of this type require a significant amount of compressive force to pre-load and release the plexor.

Where a frictional or clutch type engagement is employed between the intermediate member and the control element and/or the operating component of the lighter, it is necessary to maintain a sufficient force on the safety button while the trigger is operated in order to ensure sufficient frictional engagement between the friction surfaces to transfer the necessary force from the trigger to the operating component. By arranging the intermediate member to transfer motion to the piezoelectric device, the further advantage is therefore realised that a substantial amount of force must be exerted on the safety button throughout the lighting operation in order to prevent the friction surfaces from slipping past each other under the relatively heavy load placed on the trigger by the user's digit.

The enabling force may be applied via a small safety button as shown, which makes it particularly difficult for small children to operate the lighter. Alternatively a larger, perhaps pivoted or flexible handgrip area may be formed on the casing of the lighter so that the pressure of the user's hand on the handgrip is transferred to the intermediate element to set it to the enabled condition; the handgrip may be biased by a strong spring or the like, requiring a minimum enabling force which corresponds to the normal minimum grip strength of the average adult user. The user must therefore maintain their grip on the lighter throughout the process of depression of the trigger.

Alternatively, in a less preferred embodiment the trigger 30 may be arranged for movement in a first, enabling direction – for example, for upward translation into the body of the lighter, or rotational movement – which forces the intermediate member against a sliding surface formed on the lighter body and so sets it in the enabled condition, before the trigger is depressed in a second, actuating direction. Thus pressure must be maintained in the first, enabling direction whilst depressing the trigger to achieve ignition. Similar arrangements may be applied to the fifth lighter described below.

Referring to Figs. 5A – 5E, a fifth lighter includes a first control means or trigger 30 and enabling means formed as a second control means or safety button 50, together with a piezoelectric device 20 similar to that of the previously described embodiments. The trigger is normally biased towards the rest position as shown in Figs. 5A and 5B by means of a spring 38. The safety button is shown without locking means, although it may alternatively include locking means as described above, and is operable to enable the intermediate member by depressing it downwards in the direction C as shown in Figs. 5D and 5E. It is biased upwardly towards the rest position by a spring 51. An enlarged sliding surface 58 is formed on the lower end of the stem 52.

As described with reference to the fourth lighter, stop surfaces 32, 33 formed respectively on the trigger and on the lighter body define a maximum distance of displacement M of the trigger in the first direction A, which in turn determines the maximum length of stroke of the actuating motion which can be imparted by the trigger 30 to the piezoelectric device 20.

The intermediate member 80 includes a flexible intermediate section comprising two rigid arms 81, 82 which are joined together by a pivoting joint 83. The ends 84, 85 of the intermediate member are attached respectively to the trigger 30 and to the piezoelectric device 20 by further pivoting joints; alternatively they might engage in sockets or the like which permit pivoting movement, or they may be formed as integral resilient elements. The trigger and the piezoelectric element are separated by a variable distance defined by the variable length of the intermediate section of the intermediate element between its two ends 84, 85, which is to say, the distance in a straight line between the two ends 84, 85 which varies with the progressive outward or transverse displacement of the intermediate section as further described below.

In the rest condition (Figs. 5A, 5B) the intermediate element is fully extended so that the arms 81, 82 lie as shown generally in parallel with the first or actuating direction A of the trigger, but with the intermediate section sloping slightly towards the enabling means on either side of the pivot 83.

In the disabled condition the safety button 50 remains in its rest position as shown in Figs. 5A – 5C, so that the intermediate section of the intermediate element 80 may be freely displaced in a direction D generally transverse to the direction A of the actuating motion by depression of the trigger, as shown in Fig. 5C. This displacement of the intermediate section causes the two ends 84, 85 to approach each other, shortening the distance of separation between the trigger 30 and the piezoelectric device 20, so that no actuating motion is transferred to the piezoelectric device and ignition is not achieved.

In order to operate the lighter the safety button 50 is first depressed in the enabling direction C , with the intermediate member in the rest position shown in Figs. 5A and 5B, so that the surface 58 bears slidingly on the pivot 83. This sets the intermediate member in the enabled condition. The trigger 30 is then depressed in the first direction A while the safety button 50 is maintained in the fully depressed position, whereon the intermediate section of the intermediate element 80 slides along the surface 58, which restrains the intermediate section from transverse displacement in the direction D (Figs. 5D, 5E.) This maintains the maximum extension of the intermediate element and hence the distance of separation between the trigger and the piezoelectric device, enabling the intermediate element to transfer the actuating motion A from the trigger to the piezoelectric device and thus to achieve ignition.

As described above with reference to the fourth lighter, the distance of separation between the trigger and the piezoelectric device (or valve lever) during operation of the trigger is thus proportional to the force applied to the safety button. The piezoelectric device is preferably arranged so as to be inoperable by an actuating stroke shorter than the maximum trigger stroke M, ensuring that successful operation of the lighter is dependent on a sufficient force being continuously maintained on the safety button during depression of the trigger.

In alternative embodiments the flexible intermediate element is formed as a resilient element without a central joint which can bend outwardly in its midsection under axial compression. It may be moulded integrally with the trigger or the piezoelectric device and engage the other component with its distal end, for example by means of a socket. Additional pivoting joints may be provided. The ends of the intermediate element might also be operatively connected to the trigger and to the piezoelectric device or valve by any other means which allows the trigger pressure to be transferred via the intermediate element to the operating

component, such as by attaching them to other, intermediate components, rather than by directly attaching them as described above.

It is found that when children attempt to operate a lighter, they may exert erratic or transient forces on the control elements (triggers or buttons), for example by banging them or forcing them against the floor or furniture, but find it much more difficult to maintain a constant force. Furthermore, children will find it particularly difficult to maintain a constant force on two separate control elements, particularly when they are spaced apart on the casing of a utility lighter which is sufficiently large for a small child to be unable to grasp it and reach both buttons with one hand.

By arranging for the force required to be applied to the safety button to maintain the intermediate element in the enabled position to be proportionately large in relation to the force required to be applied to the trigger, and by requiring the force to be applied constantly and simultaneously to both the trigger and the safety button, embodiments of the invention thus enjoy a particularly high degree of child resistancy. This is conveniently accomplished as described above by arranging the intermediate member to transfer motion to the piezoelectric device, requiring a substantial force to be exerted on the trigger in order to compress the plexor spring, while forming the engagement surfaces so that they can slip past each other under the actuating load from the trigger.

In alternative, less preferred embodiments however the intermediate member may be arranged to transfer the actuating motion to the valve mechanism instead of to the piezoelectric device.

In the first and second lighters described above, the intermediate member may be considered to be a flexible extension of the first control element or of the piezoelectric device. In yet further embodiments, the piezoelectric element, or a lever or other suitable mechanism for controlling the fuel valve, may for example

be flexibly mounted and engaged with the first control element by transverse pressure from the enabling means, such as a safety button similar to that of the foregoing embodiments, so that the operating component itself performs the function of the intermediate element. Alternatively the first control element itself may be flexibly mounted and engaged in a similar way directly with the piezoelectric device or the valve lever.

Other means may be employed for setting the lighter from the disabled condition to the enabled condition. Accordingly a yet further piezoelectric lighter provides suitable enabling means for setting the lighter from a disabled condition, in which the actuating movement of the trigger is not transferred to at least one of the operating components (piezoelectric device and/or fuel release valve) of the lighter, to an enabled condition in which the displacement of the trigger is transferred to actuate the operating component so as to produce a flame.

Disengagement means are provided for returning the lighter automatically to the disabled condition in the event that the user interrupts operation of the enabling means – for example, by relaxing his pressure on the safety button so that it falls below a predetermined minimum pressure – during displacement of the trigger and before the lighter is ignited. In order to achieve ignition, the user must therefore continuously operate the enabling means during displacement of the trigger in the first direction, for example by maintaining continuous pressure on a safety button, until the lighter ignites. This ensures that a child playing with the lighter by alternately operating the trigger and the safety button will not achieve a flame if he lets go of the safety button even for an instant while he presses the trigger.

In the first, second and third lighters described above, this function is desirably provided by the slanted engagement surfaces which urge the intermediate member out of engagement when the safety button is released during operation of the trigger. In the fourth lighter, the frictional engagement surfaces form

disengagement means, so that when the safety button is relaxed the intermediate element is disengaged from the operating component and/or from the trigger. In the fifth lighter the transversely displaceable intermediate section of the intermediate member forms the disengagement means, by automatically shortening the effective stroke from the trigger as it is applied to the operating component (piezoelectric device and/or trigger). Alternative ways of implementing such disengagement means will be evident to those skilled in the art.

In order to make operation of the lighter still more difficult for children, the lighter is preferably configured so that after it has been returned to the disabled condition by the disengagement means, it cannot be reset to the enabled condition until the first control element is returned to the rest position. This may be achieved for example by means of the blocking surfaces as described above with reference to the first, second and third lighters. Alternatively frictional engagement surfaces can be used for this purpose, as described with reference to the fourth lighter; the surfaces can be engaged at any position as the trigger is progressively displaced, but engagement in any but the initial rest position of the trigger will not transfer a sufficiently long operating stroke to operate the piezoelectric device or the valve. Other means will readily be conceived.

This constrains the user to return the trigger to the rest position if the safety button is inadvertently released during operation of the trigger. In order to still further enhance the child resistancy of the lighter, the enabling means may be arranged to be operable to set the lighter to the enabled condition when the trigger is in the rest position, but inoperable to set the lighter to the enabled condition when the trigger is displaced through at least an initial predetermined distance in the first direction. As described with reference to the first, second and third embodiments, this initial distance may be determined by the size of the gap between the engagement surfaces of an intermediate element and the corresponding operating component or trigger; alternative means may be equally suitable. The child is thus

preferably prevented from achieving ignition if the safety button is operated after more than a negligible initial movement of the trigger.

By implementing the abovedescribed means in combination, the lighter may be arranged to present an insuperable intellectual barrier to operation by children less than five years in age.

In summary, embodiments of the invention comprise a child resistant piezoelectric gas lighter, such as a cigarette lighter or a utility lighter, which includes an intermediate member and a safety button which is operable to set the intermediate member from a disabled condition, wherein the trigger is depressible without actuating the the piezoelectric spark generator or, less preferably, the valve, to an enabled condition wherein the intermediate member transmits the actuating motion from the trigger to the piezoelectric device to generate a spark and operate the lighter. The intermediate member may be a resilient leaf mounted at a fixed point on the trigger or piezoelectric device or may be a separate element mounted on the lighter body for translational movement and engaging both components. The safety button must preferably be depressed before the trigger and held down until the lighter ignites. The intermediate member may engage one or both components frictionally so that insufficient pressure on the safety button results in slippage of the intermediate member and reduces the length of the actuating stroke transmitted to the piezoelectric device or fuel valve, preventing operation of the lighter. Alternatively the trigger may directly frictionally engage the piezoelectric device. Alternatively the intermediate member includes a flexible middle section which is sidewardly restrained by the safety button.

The embodiments illustrated are not exhaustive, and many adaptations and developments may be made thereto without departing from the scope of the claims.